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BUREAU OF CHEMISTRY—BULLETIN No. 87.

H. W. WILEY, Chief of Bureau.

CHEMICAL COMPOSITION OF SOME TROPICAL FRUITS AND THEIR PRODUCTS.

I. A Study of Cuban Fruits.

II. The Composition of Fresh and Canned Pineapples.

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BY

ED. MACKAY CHACE, L. M. TOLMAN, AND L. S. MUNSON,

Assistant Chemists, Food Laboratory.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., August 22, 1904.

Sir: I beg to transmit for your inspection and approval a manuscript containing the results of certain investigations on the chemical composition of tropical fruits. Aside from the scientific interest of this study the principal object kept in view has been to make such a presentation of the facts of the case as may be of value to the citizens of the possessions of the United States lying within the Tropics. The cooperation of the expert of the Bureau of Plant Industry in charge of tropical agriculture was secured in the identification of the fruits, and the manuscript has received his approval in regard to all points in which the investigation touches upon the strictly pomological phase of the study. I have the honor to recommend that this report be published as Bulletin No. 87 of the Bureau of Chemistry.

Respectfully,

H. W. Wiley, *Chief.*

Hon. James Wilson,
Secretary of Agriculture.

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LETTER OF SUBMITTAL.

DEPARTMENT OF AGRICULTURE,
DIVISION OF FOODS, BUREAU OF CHEMISTRY,
Washington, D. C., August 22, 1904.

SIR: I herewith submit the report of recent work done in the Food Laboratory, now the Division of Foods, with a number of tropical fruits and fruit products, especially fruits grown and products manufactured in the island of Cuba. The recent acquisitions by the United States of tropical territory make further information regarding tropical fruits of great interest. The fruits mentioned in this report are grown either in the Philippine Islands or in Porto Rico, and many of them are grown in both places. In many cases these fruits grow wild and have at present no commercial importance in those localities. At the same time it is apparent that with proper treatment they should have a large degree of commercial importance. All of the prepared fruit products from Cuba could also be made advantageously in Porto Rico, and should be brought to the attention of consumers in the United States.

Pineapples are extensively canned in the Bahamas and the Straits Settlements. The extension of this industry to the insular possessions of the United States would also seem practicable. The presence of Mr. Chace in Havana for a number of months afforded him exceptional opportunities to study the nature of fruit products manufactured and used in that locality and to secure samples.

Respectfully submitted.

W. D. BIGELOW,
Chief of Division of Foods.

DR. H. W. WILEY,
Chief of Bureau of Chemistry,
U. S. Department of Agriculture.

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CHEMICAL COMPOSITION OF SOME TROPICAL FRUITS AND THEIR PRODUCTS.

I.—A STUDY OF CUBAN FRUITS.

INTRODUCTION.

There has been practically no work done on the chemical composition of tropical fruits other than the banana and the orange, and it is only recently that the pomologist has given them much attention. Even now the majority of these fruits are ignored commercially and it is hoped that this report will aid in calling attention to some of the comparatively unknown fruits of the near-by islands of the West Indies, some of which undoubtedly have economic value.

Among the fruits examined are some which at least are commercial possibilities. The mango and sapota are both pleasant to the taste in the fresh state; they mature when picked green, and will stand shipping if properly packed. The mamey de Santo Domingo and the sour orange make excellent preserves and with some care and ingenuity in manufacture others might be made marketable. The superiority of guava pastes and jellies has long been conceded.

The fruits were sampled by Mr. E. M. Chace, in Havana, Cuba, in the height of the season of 1902. Both the fresh and preserved samples were purchased in that city and the retail prices are given. The ripe portions of the fresh fruit samples were analyzed by Mr. Chace, in Havana, the green fruits being sent to Washington, where, after ripening, they were examined by Mr. Tolman and Mr. Munson. In this way complete data were obtained on all the samples except one. When possible samples of the preserved fruit were purchased in order to test the quality and make a comparison with the fresh sample. All the preserves possessed the same objectionable feature—they were too sweet and contained too little acid, a matter easily remedied, however. As a rule, the preserves were made from good fruit and no glucose was used.

CITRUS FRUITS.

Prior to the American occupation of Cuba nothing had been done toward taking advantage of the great opportunities for raising citrus fruits. During that period a considerable quantity of Florida orange stock was imported, and during the past year (1903) some oranges have been exported. The industry is important on account of its possibilities rather than because of its present condition. As the United States would constitute the principal market, the methods of selection, grafting, and curing, and tariff conditions would determine largely whether the Cuban fruit could compete with that of Florida and California.

While grape fruit and limes grow in a semicultivated or almost wild condition and find a ready sale in the markets of Cuba, no effort is made to export them or to increase the volume of the output. The lemon (*Citrus limon*) grows only in a few private gardens, and the native fruit is never offered for sale, although there seems to be no reason why it should not be cultivated to advantage.

TABLE I.—*Citrus fruits and preserves.*

Laboratory No.	Description of sample.	Average weight of fruit.	Edible portion.	Waste.	Solids.	Insoluble solids.	Ash.		Acids as sulphuric.	Protein. (N.×6.25)	Sugars.				Polarizations.		
							Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose by reduction.	Sucrose by polarization.	Total.	Direct.	Invert.	Temperature.
		Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	°*V.*	°*V.*	°*C.*
484	Orange, "china"[a]	187.0	74.33	25.67	13.00	0.560	0.490	0.347	0.774	0.718	3.15	.....	4.33	7.48	+ 3.20	− 2.70	22.0
	.....do	166.0	72.30	27.70	14.36	.....	.520	.400	.770	.....	.....	.....	4.40	.....	+ 3.05	− 2.88	22.0
624	Orange, sweet, thick skin	296.0	71.40	28.60	14.81	2.26	.482	.....	.343	.681	4.45	5.43	5.29	9.74	+ 3.70	− 3.19	23.0
	.....do	288.0	67.50	32.50	13.69	.....	.550	.430	.440	.626	3.02	.....	4.80	7.82	+ 3.20	− 3.08	26.0
502	Orange, sour	.....	59.10	40.90	12.92	2.31	.....	.....	2.018	.574	3.64	.....	2.87	6.51	+ 1.80	− 2.20	19.0
	.....do	257.6	59.00	41.00	12.57	.....	.570	.450	2.010	.....	.....	.....	2.70	.....	+ .90	− 2.65	22.0
506	.....	118.0	83.33	16.67	11.38	2.70	.352	.357	.161	.581	5.58	None.	None.	5.58	+ 1.40	+ 1.40	20.0
829	Pasta de naranja	.....	.....	.....	86.75	5.96	.357	.434	.118	.312	20.77	56.84	55.65	76.42	+52.10	−19.56	27.0
890	Mermelade de naranja	.....	.....	.....	72.49	2.34	.140	.170	.042	.169	17.85	50.57	49.77	67.62	+46.50	−17.60	27.0
885	Naranja en almibar	.....	.....	.....	63.44	3.57	.162	.239	.032	.156	3.89	56.56	54.92	58.81	+53.90	−18.00	22.0
904	Cascos de naranja	.....	.....	.....	67.44	2.77	.130	.194	.036	.187	5.25	57.85	57.27	62.52	+56.00	−18.96	22.8
504	Grape fruit	477.0	69.20	30.80	13.29	2.70	.393	.369	.540	.581	3.11	.....	3.11	6.22	+ 3.40	− 2.50	19.0
	.....do	391.6	73.00	27.00	13.12	.....	.390	.360	.560	.563	2.60	.....	4.77	7.37	+ 3.00	− 3.24	26.0
	.....do	378.0	.....	.....	9.94	1.17	.460	.310	.588	.....	1.69	.....	4.20	5.89	+ 3.20	− 2.20	28.0
821	Limes	27.0	78.2	21.8	14.77	3.97	.673	.644	5.515	.831	.34	None.	None.	.34	0.00	0.00	.....
	.....do	26.0	69.0	31.0	14.84	.....	.980	.730	4.800	.....	.42	.....	.16	.58	0.0	− .22	26.0
889	Limes (preserved)	.....	.....	.....	68.64	5.03	.164	.215	.078	.225	36.31	26.55	26.66	62.97	+18.70	−16.20	22.8
671	Sweet lemons	.....	.....	.....	11.23	2.43	.615	.535	.130	.870	5.99	1.34	1.22	7.21	− .50	− 2.09	23.0
	.....do	110.6	71.0	29.0	10.37	.....	.980	.410	.070	.....	4.28	.....	.99	5.27	− .90	− 2.20	25.0
	Sweet limes	122.0	80.1	19.9	10.65	.....	.390	.280	.120	.....	4.24	.....	.94	5.18	− 1.55	− 2.80	22.0

[a] In each case where two analyses are given, the first, with a serial number, was made in the Washington laboratory on the fruit ripened off of the tree, and the second, unnumbered, was made at Havana on the fresh fruit.

ORANGE (NARANJA).

(*Citrus aurantium.*)

The oranges of Cuba as a rule are smaller, more fibrous, and contain more seeds than the same varieties grown in this country, but they are very juicy and have a good flavor. These qualities could undoubtedly be improved by modern methods of selection, grafting, and cultivation. The fruit retails at a very low price in the Havana market, sometimes selling for 50 cents a hundred, although the usual price is from 60 cents to $1.

Two varieties of orange (*Citrus aurantium*) were found, one a thin-skinned small fruit known as the "china," and the other a much larger fruit with a thick skin. The former is superior in quality, having less fiber and a better flavor. Table I, on citrus fruits and preserves, giving the composition of these fruits, shows that there is but a slight difference between these varieties in the content of sugar. The "china", however, contains twice as much acid and only one-fourth the amount of insoluble solids as the thick-skinned orange. In this it resembles the American varieties, the analysis of 80 samples of which gave 1.28 per cent of acid and 10.68 per cent of sugars.[a]

In sample No. 506, Table I, the very exceptional fact is noted that the polarization after inversion was to the right, showing a different ratio between the dextrose and levulose than that which usually exists in fruits, right-hand readings being very rare. In some previous work on fruits done in this Bureau[b] an exception of this kind was also noted in the case of a sample of plums which after inversion gave a reading of +1.3.

The bitter orange, "naranja agria" (*Citrus bigaradia*), resembles the large, thick-skinned, sweet orange in appearance, having a somewhat thicker skin, but being about the same size. It grows in a semi-wild state in many parts of the island, but is little used except for making "dulces" (sweets). Some of the finest Cuban preserves are made from this fruit. The chief difference between this variety and the sweet orange is in the amount of acid present, both containing about the same amount of sugars.

Four kinds of orange preserves were examined. "Pasta de naranja" is a thick orange paste sold in wooden boxes lined with paper. This packing is not sufficient to protect the preserves, as a sample kept in the laboratory dried out and became wormy in the course of a year. The paste was probably made by boiling down the pulp and inner skin of the orange. Owing to the small amount of acid present but little of the cane sugar was inverted.

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[a] Colby, California Agr. Expt. Sta. Rept., 1892–93, p. 246.

[b] U. S. Dept. of Agr., Bureau of Chemistry, Fruits and Fruit Products: Chemical and Microscopical Examination, Bul. No. 66, p. 49.

"Mermelade de naranja" is similar to the orange marmalade found on the American market. Analyses of American and European marmalades given in Fruit and Fruit Products[a] show that these contain less sugar and more acid than the Cuban products. This gives the former a tart flavor, while the latter are somewhat insipid. The sample was put up in glass.

The "naranja en almibar," or orange in sirup, consists of pieces of orange preserved in a heavy sirup and put up in glass. The "cascos de naranja," or preserved orange skins, are made by scraping or rasping the skins of oranges to remove the outer yellow part and cooking them in a heavy sugar sirup. These preserves have a pleasant flavor and are the most palatable of the orange preserves examined. This sample was put up in tin cans, a method not generally employed in Cuba.

GRAPEFRUIT (TORONJA).

(*Citrus decumana.*)

This is a popular fruit in Cuba. It has a mild, pleasant flavor, and is quite different from the acid, bitter fruit to which we are accustomed. It retails in Havana at about 2½ cents apiece. The analyses given in Table I show its composition to be like that of the sweet thick-skinned orange. Two analyses of grapefruit made by Colby[b] show that the California product is a very different fruit, having about four times as much acid as the Cuban grapefruit and only slightly more sugar.

No grapefruit preserves were found on the Cuban markets. In California a preserve called grapefruitate, which is really a marmalade and very similar to orange marmalade in taste and composition, is being made from grapefruit.

LIME (LIMONCILLO).

(*Citrus hystrix acida.*)

The lime grows wild in all parts of Cuba and replaces the lemon entirely for domestic uses, making beverages, etc., as it is used without the curing which the lemon undergoes, and, either in the ripe or green state, it is on the market during all seasons of the year. In composition the Cuban lime closely resembles the California lemon. The average of 22 analyses made by Colby[c] is 5.26 per cent of acid (calculated as sulphuric) and 2.33 per cent of sugar.

The sample of preserved limes resembles closely the "cascos de naranja," being made of fruit from which the juice had been expressed,

[a] U. S. Dept. of Agr., Bureau of Chemistry, Bul. No. 66, p. 61.
[b] California Agr. Expt. Sta. Rept., 1892–93, p. 256.
[c] California Agr. Expt. Sta. Rept., 1892–93, p. 249.

as shown by the low acid content of the preserve. No samples of lime juices were found.

The sweet limes and lemons analyzed could not be positively identified. These fruits are little used, being offered for sale chiefly in the larger markets on account of their alleged medicinal qualities. They possess a highly aromatic odor and taste and their composition is not unlike that of the sweet orange, except that they contain a very low percentage of acid.

TAMARIND (TAMARINDO).

(*Tamarindus indica.*)

The tamarind is the fruit of a leguminous tree. The fruit is a dark brown pod, from 1 to 6 inches long and from ¾ to 1 inch in width. Small indentations on the pod roughly mark the location of the seeds within. The exterior skin is thin and very brittle. Within, there is a thick dark-colored pasty material closely surrounding the tough seed sacks and joined to the stem of the pod by several coarse fibers. This paste constitutes the edible portion of the fruit and is so intensely sour in taste that the 30 per cent of sugar which it contains is entirely masked and can only be detected by a slightly sweet aftertaste.

The tamarind of all the fruits examined is remarkable in that it has the highest content both of acids and of sugars. It contains a higher percentage of acid than the lime and more sugar than any of the sweet fruits. As would be expected, in the presence of so large an amount of acid but little cane sugar is found.

A study of the process of the ripening of the tamarind would be of great interest on account of this remarkable ratio between the acid and sugar. H. C. P. Geerlings,[a] reporting on the sugar content of the tropical fruits from Java, gives that of the tamarind as only 8.32 per cent, working perhaps on the green fruit. The fruit is used in making refreshing summer beverages and for flavoring soda-water sirups. It has mild purgative properties, and is used in this country in preparing the confection of senna.

[a] Chem. Ztg., 1897, **21**: 719.

TABLE II.—*Tamarinds and preserved products.*

Laboratory No.	Description of sample.	Average weight of fruit.	Edible portion.	Waste.	Solids.	Insoluble solids.	Ash.		Acids, as sulphuric.	Protein. (N.×6.25)	Sugars.				Polarizations.		
							Total.	Alkalinity, as potassium carbonate.			Reducing.	Sucrose by reduction.	Sucrose by polarization.	Total.	Direct.	Invert.	Temperature.
		Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	° *V.*	° *V.*	° *C.*
687	Tamarinds	.....	.....	.....	52.53	8.61	1.56	1.39	6.03	1.36	31.00	0.24	0.43	31.43	— 6.80	— 7.98	23.0
	.....do	7.8	51.30	48.70	64.75	.....	.....	.....	9.31	2.44	29.31	.....	1.05	30.36	— 2.60	— 3.96	29.0
801	Tamarind paste	.....	.....	.....	92.52	.87	.36	.26	.95	.46	13.53	77.81	75.46	88.99	+72.00	—25.16	27.2
813	Pulpa de tamarinda	.....	.....	.....	92.93	.74	.43	.37	.89	.41	16.55	75.15	72.46	89.01	+68.40	—24.90	27.2

TABLE III.—*Guava and guava preserves.*

Laboratory No.	Description of sample.	Average weight of fruit.	Solids.	Insoluble solids.	Ash.		Acids as sulphuric.	Protein. (N.×6.25)	Sugars.				Polarizations.		
					Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose by reduction.	Sucrose by polarization.	Total.	Direct.	Invert.	Temperature.
		Grams.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	° *V.*	° *V.*	° *C.*
23739	Guava [a]	.....	22.14	11.75	0.630	0.470	0.629	0.970	6.07	0.27	.....	6.34	—4.70	— 4.90	21.0
23740	.....do. [a]	.....	19.61	11.88	.653	.....	.369	.790	4.57	.91	.....	5.48	—3.75	— 4.60	21.0
	Pear-shaped guava	87.0	21.70	.....	.630	.470	.520	.....	.....	.....	.....	.....	.....	.....	.....
871	White guava	43.0	21.81	15.21	.838	.672	.636	.....	2.84	.16	.....	3.00	.....	.....	.....
814	Guayaba crystalizada	.....	86.25	4.37	.513	.384	.299	.356	27.12	53.48	53.20	80.32	45.20	—23.30	27.2
815	Jalae de guayaba	.....	82.01	.....	.424	.368	.370	.106	29.71	50.17	50.25	79.96	41.90	—22.80	27.2
822	Creme de guayaba	.....	80.93	5.09	.527	.379	.363	.388	21.18	51.62	52.15	73.33	45.75	—21.40	27.2
817	Pasta de guayaba	.....	83.04	4.51	.590	.428	.402	.250	17.04	59.17	58.57	75.61	53.35	—22.20	27.0
816	.....do	.....	85.27	4.66	.553	.394	.360	.425	17.78	59.89	60.12	77.90	54.95	—22.60	27.0
891	Cascos de guayaba en almibar	.....	63.34	6.57	.199	.210	.208	.281	34.52	23.03	23.30	57.82	12.50	—18.00	22.8
907	.....do	.....	69.18	5.41	.329	.275	.190	.262	36.06	25.97	26.10	62.16	14.75	—19.58	23.0
902	.....do	.....	72.13	7.08	.143	.156	.095	.262	28.22	38.28	36.46	64.68	27.90	—18.48	23.0

[a] Further description lost.

Two samples of preserves were examined, a tamarind paste and a pulp, having almost the same composition, as is shown in Table II. These products are evidently made by mechanically mixing granulated sugar and tamarind pulp, as it would hardly be possible to evaporate the mixture to the density of the samples without more inversion of cane sugar than is shown. An average of the results obtained on the samples of fruit analyzed shows these pastes to be composed of about 20 per cent of pulp and 80 per cent of sugar. They are used for the same purposes as the fresh fruit when the latter is out of season, and have a sweet acid taste. The pastes are put up in 1-pound packages, with an inner wrapper of oiled paper or tinfoil and an outer one of coarse brown paper.

GUAVA (GUAYABA).

(*Psidium guajava.*)

There are several varieties of guava growing wild in all parts of Cuba, and this fruit is also grown in California and Florida. The guava is not eaten raw, but the finest jellies, pastes, etc., are made from it. Besides the two varieties analyzed, the white and the pear-shaped, there is a third sometimes used for making low-grade pastes, when the dark color is not objectionable. This variety is similar to the white guava, but has a colored pulp.

The white guava (guayaba blanca) is a small, round fruit, grayish-white or yellow in color and averaging about 45 grams (1.5 ounces) in weight. The pear-shaped fruit (guayaba de Peru) is about twice the size of the white variety, but closely resembles it in odor, color, and flavor. Both varieties contain large numbers of small, hard seeds scattered throughout the yellowish-white pulp, and have the acid taste and peculiar odor characteristic of the fruit. The composition of the samples as given in Table III shows a remarkable amount of insoluble material.

Eight samples of guava preserves were analyzed. The jellies and pastes of this fruit, and the orange marmalade already noted, are the only fruit products which can be compared with products of the same kind in this country. The guava preserves, unlike the orange, are very similar to those of American make, the crystallized guava, the guava cream, and pastes corresponding to the marmalade of the American trade. Several analyses of American guava marmalades will be found in Fruits and Fruit Products.[a]

All the samples, except the "cascos de guayaba," which are packed in glass, are put up in wooden boxes lined with paper. The crystallized guava, the cream, and the pastes analyzed contained nearly 80 per cent of sugar, some of which had crystallized out. The "cascos de gua-

[a] U. S. Dept. of Agr., Bureau of Chemistry, Bul. No. 66, p. 61.

yaba en almibar" are the skins and adhering pulp of the guava, preserved in a thick sirup. These preserves have a very low acid content, and are quite different from the fruits preserved in a heavy sirup which are made in this country, where only acid fruits, such as cherries, peaches, etc., are put up in this way.

BANANA (PLATANO).

(*Musa.*)

Great quantities of bananas are grown in Cuba, but very little of this fruit is exported, most of it being consumed by the lower classes, as it forms one of their principal foods. It was impossible to identify all of the varieties analyzed. Two samples, however, were classified by O. F. Cook, in charge of tropical agriculture, Bureau of Plant Industry, as identical with those known as the niño and manzano in Porto Rico. The other varieties are designated by the local name, which as a rule has no meaning outside of the district where the banana is sold. All of the fruits examined were true bananas, which are eaten raw, the plantains being boiled or fried.

A large part of the banana is edible and contains a high percentage of solid material. The percentage of insoluble solids in the edible portion depends upon the state of ripeness of the fruit, as does the amount of total sugar and the relative proportion of cane and invert sugar. Work done in this laboratory shows that as the fruit ripens there is a change of starch into cane and invert sugar and of cane sugar into invert sugar. On very ripe bananas the results for total sugar are very high and those for starch very low.

The manzano, niño, and "ciento a la boca" are all small, yellow bananas, having very thin skins, yellow pulp, and very fine flavors. They are all sweet, the "ciento a la boca" especially so. These varieties will not stand shipment and so are not exported. They make a very palatable dish when fried, though usually they are eaten raw.

TABLE IV.—*Bananas.*

Laboratory No.	Description of sample.	Average weight of fruit.	Edible portion.	Waste.	Solids.	Insoluble solids.	Ash.		Acids as sulphuric.	Protein. (N×6.25)	Sugars.				Polarizations.		
							Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose by reduction.	Sucrose by polarization.	Total.	Direct.	Invert.	Temperature.
		Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	°*V.*	°*V.*	°*C.*
472	Niño				28.09		0.700				20.42	0.19		20.61	− 6.60	−6.60	21.0
473	Manzano				30.92		.700				19.66		0.30	19.96	− 6.00	−6.40	21.0
	.....do	48.0	83.60	16.40	30.55		.850	0.520	0.390								
474	Banana[a]				30.44		.770			1.360	21.43	.28	.30	21.73	− 6.60	−7.00	21.0
686	Indiano	113.0	65.50	34.50	27.06	3.34	.982	.766	.432	.890	8.44	12.29	13.17	21.61	+10.30	−6.93	23.0
	.....do	120.0	62.10	37.90	27.16		1.100	.730	.390	.840	17.06			17.06	− 4.90	−4.84	29.0
665	Johnson	64.0	67.30	32.70	24.34	2.23	.819	.454	.176	1.130	14.69	4.99	5.20	19.89	+ .50	−6.27	24.0
702	Johnson (bought in Washington)		65.10	34.90	26.13	4.35	.848	.575	.333	1.125	7.88	11.73	13.83	21.71	+11.30	−6.38	27.0
703	.....do		64.50	35.50	26.24	3.95	.860	.568	.343	1.212	8.49	11.69	13.27	21.76	+10.70	−6.27	27.0
696	Ciento a la boca	31.6	80.70	19.30	31.97	4.52	.824	.701	.205	1.230	8.07	16.20	17.59	25.66	+15.05	−8.19	20.0
	.....do	30.6	72.80	27.20	34.55		.930	.650	.200	1.220	7.35						
666	Colorado (red)	130.0	77.20	22.80	21.60	2.28	.827	.556	.166	1.180	5.78	11.69	11.35	17.13	+ 9.70	−5.06	24.0
800	Colorado (red) (bought in Washington)	120.0	66.00	34.00	25.16	4.09	.863	.723	.394	1.208	9.56	9.49	10.36	19.92	+ 7.65	−5.61	27.6
503	Oronoco (red)	128.0	73.44	26.56	23.34	2.47	.801	.635	.254	1.331	3.16		12.20	15.36	+10.85	−5.20	19.0
	.....do	127.5	70.40	29.60	25.51		1.080	.730	.280				16.54		+15.60	−5.60	25.0

[a] No further identification.

The oronoco and colorado are red bananas very much like those offered for sale in our markets, and their flavor is not the best. One of the samples reported in Table IV was purchased in Washington. The indiano is a large, yellow, angular fruit with a salmon-colored pulp and a rather disagreeable, acid flavor. The Johnson is the variety exported to this country from Jamaica and Central America. It has rather an inferior flavor when compared with the smaller fruits, but stands shipping better than other varieties. Two of these samples were bought in Washington.

MANGO.

(*Mangifera indica.*)

The mango is the popular tropical fruit of the native Cuban. It grows in all parts of the island, on trees by the roadside and in orchards of highly prized cultivated fruit. The kinds that have been cultivated only slightly appeal but little to the foreigner, being very fibrous and having a strong resinous flavor. Both of these objections are overcome in the well-cultivated varieties, however, and very soon a taste is acquired for all.

The fruit is heart-shaped, some being long and narrow, while others are broad and short, or almost round. The skin is like that of an apple, but thicker, and varies in color from green to yellow, always shading to red on one side. The pulp is not unlike that of a peach in texture and color and is extremely juicy. The stone or seed is very large compared with the rest of the fruit, and this is especially true of the uncultivated varieties. Long fibers cover the stone and run through the pulp of the fruit. The season in Cuba lasts from May to September. The mango is preferred in the raw state, but is used somewhat in the preparation of jams and jellies, and the green fruit when stewed resembles rhubarb.

The "manga" is one of the uncultivated varieties growing in all parts of Cuba. It has the strong resinous flavor characteristic of the common fruit, a large seed, fibrous pulp, and inferior flavor. The amount of sugar present, however, is about the same as that in the cultivated varieties.

The manzano, or apple mango, is one of the smaller cultivated varieties, nearly round in shape and very highly colored. The seed is large—in one case it was over half the weight of the fruit. This variety is not so sweet as the others, the flavor being rather too acid.

The Filipino is the finest mango grown in Cuba. It is the largest of the native varieties, often weighing over half a pound. In flavor it is superior to any other, having none of the resinous flavor of the common fruit. It stands shipment well, which, combined with its other fine qualities causes it to bring the highest prices. When other

varieties are selling at 5 cents a dozen the price of the Filipino will vary from 30 to 50 cents, and often it reaches a dollar. One tree is known to have produced in one season fruit bringing $75. This variety contains the largest amount of sugar of any of those examined. The French is also one of the better varieties, having fewer of the disagreeable qualities than most of the others.

The sample of Porto Rico mango (No. 830, Table V) was obtained from F. D. Gardner, in charge of the Porto Rican Experiment Station at San Juan, and is one of the common varieties growing there. It is very different in flavor from the Cuban fruits, having less acid and sugar, but also less fiber. The composition of some Jamaican mangos analyzed by H. H. Cousins[a] is also given in Table V. This fruit is much more acid than that from Cuba.

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[a] Bul. Dept. of Agr., Jamaica, 1903, vol. 1, pt. 11, p. 268.

TABLE V.—*Mangos and mango preserves.*

Laboratory No.	Description of sample.	Average weight.	Edible portion.	Waste.	Solids.	Insoluble solids.	Ash.		Acids as sulphuric.	Protein. (N.×6.25)	Sugars.				Polarizations.		
							Total.	Alkalinity, as potassium carbonate.			Reducing.	Sucrose by reduction.	Sucrose by polarization.	Total.	Direct.	Invert.	Temperature.
		Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	° *V.*	° *V.*	° *C.*
767	French mango	124.0	55.5	44.5	17.50	3.70	0.491	0.397	0.267	0.400	2.21	10.95	10.88	13.09	+8.00	−6.16	23.2
	do	126.0	58.8	41.2	17.14	.....	.530	.110	.220	.....	2.00	.....	11.60	13.60	+7.15	−7.92	28.0
830	Porto Rican mango	147.5	66.1	33.9	10.23	.824	.348	.327	.091	.369	5.89	.....	.....	.....	−2.50	−4.70	25.0
849	Manzano (apple) mango	86.0	48.0	52.0	12.25	1.240	.421	.337	.388	.369	2.16	7.19	7.68	9.84	+4.60	−4.29	22.6
	do	67.4	56.3	43.7	16.42	.....	.390	.260	.380	.....	1.72	.....	6.34	8.06	+7.80	−3.41	29.0
850	Filipino mango	255.0	77.7	22.3	21.60	1.20	.422	.299	.241	.700	6.14	11.99	11.60	17.74	+6.40	−8.80	22.6
	do	190.0	75.5	24.5	21.72	.....	.410	.240	.230	.....	4.34	.....	11.09	15.43	+7.70	−6.60	30.0
812	Manga	126.0	66.8	33.2	13.33	1.82	.778	.634	.335	.325	4.63	9.91	10.06	14.69	+5.20	−7.59	26.6
	do	125.0	60.8	39.2	20.63	.....	.480	.330	.320	.....	2.94	.....	11.25	14.19	+7.20	−7.37	29.0
886	Mangos en almibar	.....	.....	.....	75.39	.91	.098	.096	.150	.194	66.70	7.87	6.80	73.50	−11.50	−20.40	24.0
905	Mermelade de mangos	.....	.....	.....	38.79	1.73	.221	.192	.687	.175	38.69	.28	.....	38.97	−11.50	−11.50	24.0
	Jamaican mangos:[a]																
	No. 11	.....	59.9	40.1	18.73	.82	.38	.....	.960	.....	4.76	7.35	.....	12.11	.....	.....	.....
	Yam	.....	55.2	44.8	15.33	1.05	.36	.....	1.058	.....	2.38	6.78	.....	9.16	.....	.....	.....
	Bombay	.....	65.1	34.9	18.81	1.05	.35	.....	.980	.....	2.50	10.28	.....	12.78	.....	.....	.....
	Black	.....	53.6	46.4	22.35	1.18	.20	.....	1.058	.....	5.26	10.83	.....	16.09	.....	.....	.....

[a] H. H. Cousins, Bul. Dept. of Agr., Jamaica, 1903, vol. 1, pt. II, p. 263.

Two samples of mango preserves were examined, both of which were put up in glass. The "mangos en almibar" are pieces of mango preserved in a thick sugar sirup, while the marmalade of mangos is a thin paste resembling apple sauce in appearance. Neither sample was of good flavor.

ANONA.

There are three species of anona in Cuba which are edible. First and most important is the sour-sop, next the sweet-sop, and third the chirimoya, which is of but little importance.

SOUR-SOP (GUANABANA).

(*Anona muricata.*)

The sour-sop is a green, irregular-shaped, pod-like fruit varying from 3½ to 12 inches in length, about two-thirds as broad near the top, and curving to a blunt point at the lower end to one side of the center. The skin is rather thick and covered with numerous small, hooked briers. The pulp, which has the appearance of wet cotton, surrounds the numerous tough seed sacs containing small brown seeds. A fibrous core runs through the fruit from the stem to the lower point.

Sour-sops vary greatly in size, weighing from 100 grams (3.5 ounces) to over a kilo (2.2 pounds). The flavor is acid without being sweet. It is highly esteemed for making cooling summer beverages, flavoring soda-water sirups and water ices, and for preserving. The most popular beverage is made by macerating the fruit with sugar, diluting with water, and straining off the pulp. The fruits sell at from 10 to 25 cents apiece in the season, which lasts from May to September.

Two samples of the preserved fruit were examined. The "guanabana en almibar" is composed of the pulp of the fruit preserved in sugar sirup. The "pulpa de guanabana al natural" is the pulp preserved without sugar, being intended for café and soda-water trade when the fruit is out of season. It very closely approximates the composition of the natural fruit, as is shown in Table VI. Both samples were packed in glass.

SWEET-SOP (ANONA).

(*Anona squamosa.*)

The sweet-sop does not attain the size of either the sour-sop or the chirimoya. The samples analyzed (Table VI) averaged 229 grams (7.3 ounces) in weight. The fruit is heart-shaped and deeply creased, the portions between the creases ending in small knobs, which indicate the position of the seeds under the surface of the skin. The seeds are small and brownish black, resembling those of the sour-sop. The pulp is also very much like that of the sour-sop, but it contains more sugar and, as a rule, a smaller percentage of acids.

Sweet-sops are eaten in the fresh state and are also used in making water ices and soda water sirups. It is not so popular as the sour variety, and no preserved fruit was found on the market.

TABLE VI. *Anona and preserves.*

Laboratory No.	Description of sample.	Average weight of fruit.	Edible portion.	Waste.	Solids.	Insoluble solids.	Ash.		Acids as sulphuric.	Protein. (N×6.25)	Sugars.				Polarizations.		
							Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose by reduction.	Sucrose by polarization.	Total.	Direct.	Invert.	Temperature.
		Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	°*V.*	°*V.*	°*C.*
811	Guanabana (Sour-sop)	.....	72.30	27.70	19.03	5.45	0.407	0.367	0.508	1.65	13.07	None.	None.	13.07	− 5.60	− 5.40	26.6
	.....do	325.0	59.10	40.90	19.64	.....	.860	.510	.650	.....	9.77	None.	None.	9.77	− 4.20	− 4.18	28.0
887	Guanabana en almibar	.....	.....	.....	54.33	1.60	.430	.329	.189	.726	18.90	31.56	30.76	49.66	+25.00	−15.00	24.0
892	Pulpa de guanabana al natural	.....	.....	.....	17.06	2.22	.857	.609	.425	1.194	12.14	.28	None.	12.42	− 5.00	− 4.80	24.0
23603	Anona (Sweet-sop)	.....	.....	.....	25.44	6.19	1.111	.792	.266	2.130	13.57	.....	.60	14.17	.....	.....	.....
23604	.....do	.....	.....	.....	29.00	.....	1.094	.689	.623	2.130	.....	.....	.....	.....	.....	.....	.....
	.....do	212	26.80	73.20	28.72	4.78	.920	.660	.200	.....	11.24	.....	10.07	21.31	+ 8.00	− 5.05	25.0
	.....do	246	30.00	70.00	28.10	.....	.800	.560	.147	1.89	.....	.....	.....	.....	.....	.....	.....
	Chirimoya	444.0	57.30	42.70	27.87	.....	1.040	.770	.260	.....	.....	None.	None.	.....	− 3.60	− 3.63	26.0

TABLE VII.—*Sapotas and sapota preserves.*

Laboratory No.	Description of sample.	Average weight of fruit.	Edible portion.	Waste.	Solids.	Insoluble solids.	Ash.		Acids as sulphuric.	Protein. (N×6.25)	Sugars.				Polarizations.		
							Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose by reduction.	Sucrose by polarization.	Total.	Direct	Invert.	Temperature.
		Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	°*V.*	°*V.*	°*C.*
700	Sapota (round)	42.2	76.40	23.60	23.07	9.90	0.384	0.328	0.132	0.350	10.85	.....	.....	10.85	.....	.....	.....
766	.....do	47.2	76.02	23.98	25.47	9.17	.565	.350	.181	.494	14.50	.....	.....	14.50	−2.00	−2.09	23.0
	.....do	91.0	72.40	27.60	22.28	.....	.500	.320	.070	.388	7.34	.....	2.54	9.88	+1.10	−2.20	28.0
788	Sapota (long)	45.0	80.90	19.10	21.01	8.39	.555	.373	.162	.650	12.68	0.08	.....	12.76	−2.00	−1.98	24.0
	.....do	34.0	70.60	29.40	23.02	.....	.560	.310	.200	.....	9.37	.....	1.90	11.27	+ .60	−1.87	28.0
893	Pulpa de zapota al natural	.....	.....	.....	22.95	10.28	.399	.302	.086	.231	11.30	.....	.....	11.30	−2.25	−2.20	27.0
901	Zapotes al natural	.....	.....	.....	34.77	.89	.270	.213	.050	.200	28.35	.27	.30	28.65	−7.20	−7.59	23.0

CUSTARD APPLE (CHIRIMOYA).

(*Anona reticulata.*)

The custard apple, known in Cuba as the chirimoya, varies from a light green to a reddish brown in color and is shaped like a strawberry, being somewhat broader than it is long. It has a thick skin, black seeds, and a pulp very similar to that of the sweet-sop in appearance and flavor.

Owing to the spoiling of the samples in transit no complete analysis of this fruit was obtained, but a partial one is given in Table VI. The fruit is eaten raw, and no preserves were found on the market.

SAPOTA (SAPODILLA).

(*Achras sapota.*)

There are two varieties of this fruit in Cuba. The only apparent difference between the two is the shape, one being round and the other oval.. In the Havana market the latter is incorrectly known as the nispero, this name being properly applied to the loquat (*Eriobotrya japonica*).

The fruit averages slightly under 2 ounces in weight, is brown to greenish-brown in color, appearing not unlike a very smooth, dark potato. The skin, however, is much thicker and of coarser texture. The pulp is yellowish brown in color, granular in texture, and very juicy. It has a characteristic odor and flavor and is very sweet. The seeds, numbering from 1 to 5, are found in a soft, open core. They are brownish black, with a single white stripe, and measure from three-fourths of an inch to 1 inch in length.

Sapotas retail for 10 to 50 cents a dozen, according to quality and the season, the fruit being in season from about the 1st of April until the end of the summer. The fruit is picked green, and is said to stand shipment well. Altogether it is very popular and seems to deserve far more notice than has yet been given it by northern markets. The sap of the sapota tree and the juice of the green fruit, when boiled down, furnish what is known in commerce as chicle, from which chewing gum is made.

Two samples of preserved natural pulp were examined and the results are given in Table VII. One sample, No. 893, very closely approaches the composition of the fresh fruit, while the other, No. 901, has received the addition of about 10 per cent of sugar. The latter sample contains a very low percentage of insoluble solids and cane sugar. As usual, the acid content was very low, giving the product the insipid flavor so prevalent in Cuban preserves. Both samples were packed in glass jars.

MAMEY COLORADO.

(*Lucuma mammosa.*)

The fruit derives its local name from a very slight outward resemblance to the mammee (*Mammea americana*). The two fruits, however, are in no way related nor do they resemble each other internally. The mamey colorado is chocolate brown in color, oval or round in shape, and averages 700 grams (1.5 pounds) in weight. The skin is thick and coarse in texture. The pulp varies in color from yellowish red to deep scarlet and is slightly fibrous, firm, but mealy and not juicy. Being sweet with very little acid the flavor is insipid. It is eaten in a fresh state and also stewed with sugar.

The fruit usually contains but 1 seed, although as many as 4 are frequently found. They are embedded in a soft core and are irregularly oval, polished black on three sides and gray on the fourth. The season is from December to August, during which time mameys bring from 5 to 15 cents, according to their size.

When purchasing samples an effort was made to secure the preserves of both this fruit and the mamey de Santo Domingo, but the preserves of both varieties are labeled simply "Mamey," and on opening the cans some weeks after their purchase it was found that only the mamey de Santo Domingo had been secured.

MAMEY DE SANTO DOMINGO.

(*Mammea americana.*)

This is a large light-brown fruit, ranging from 3 to 10 inches in diameter, the larger sizes weighing upward of 700 grams (1.5 pounds). It has a heavy stem and a small blossom navel. The skin is thick and fibrous, the outer surface being tough and covered with small dark-brown spots. The pulp is dark yellow in color, firm, and very juicy. It has a sweet characteristic flavor and a pleasant aromatic odor. In the large fruits the seed measures 3 inches in diameter and is dark brown, very rough and hard, and clings tenaciously to the pulp. In some respects the fruit resembles a very large clingstone peach. It is eaten raw and is also highly esteemed for preserving, retailing at about 10 cents apiece.

Three samples of preserved mamey were examined. The "mamey en almibar" are slices of the fruit preserved in sugar sirup. The "mermelade de mamey" is a marmalade of the fruit. One sample of the "mamey en almibar" was put up in tin cans, but the others were in glass. The analyses of these products are found in Table VIII.

TABLE VIII.—*Mamey and mamey preserves.*

Laboratory No.	Description of sample.	Average weight of fruit.	Edible portion.	Waste.	Solids.	Insoluble solids.	Ash.		Acids as sulphuric.	Protein. (N×6.25)	Sugars.				Polarizations.		
							Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose by reduction.	Sucrose by polarization.	Total.	Direct.	Invert.	Temperature.
		Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	° *V.*	° *V.*	° *C.*
638	Mamey (*Lucuma mamosa*)	932.0	86.10	13.90	34.01	.....	0.800	0.390	0.100	.....	5.20	.....	16.85	22.05	+15.80	− 5.94	30.0
	.....do	.....	65.03	34.97	29.73	6.55	.825	.445	.098	1.090	20.78	0.00	.29	21.07	− 3.80	− 4.40	22.0
	.....do	668.0	73.00	27.00	29.24	.....	.890	.430	.070	.....	9.93	.....	9.94	19.87	+ 8.50	− 4.62	24.0
787	Mamey de Santo Domingo (*Mammea americana*)	623.0	60.70	39.30	14.12	4.49	.308	.301	.416	.487	3.92	5.49	.....	9.47	+ 3.10	Lost.	.....
	.....do	502.0	70.80	29.20	15.74	.....	.380	.230	.390	.....	2.50	.....	5.64	8.14	+ 4.00	− 3.30	29.0
883	Mamey en almibar	.....	.....	.....	60.05	1.96	.154	.151	.194	.363	57.00	1.73	.45	57.45	−15.00	−16.40	23.9
906	.....do	.....	.....	.....	66.32	1.93	.202	.143	.262	.344	58.68	5.10	5.15	63.83	−12.80	−19.58	23.0
895	Mermelade de mamey	.....	.....	.....	69.74	1.25	.149	.137	.123	.269	24.63	40.17	38.05	62.68	+30.70	−19.00	24.0

TABLE IX.—*Hicaco, marañon, and caimito.*

Laboratory No.	Description of sample.	Average weight of fruit.	Edible portion.	Waste.	Solids.	Insoluble solids.	Ash.		Acids as sulphuric.	Protein. (N×6.25)	Sugars.				Polarizations.		
							Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose by reduction.	Sucrose by polarization.	Total.	Direct.	Invert.	Temperature.
		Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	° *V.*	° *V.*	° *C.*
854	Hicaco	8.18	68.9	31.1	14.29	4.74	0.964	0.734	.....	0.456	5.18	0.02	0.00	5.18	− 0.70	− 0.76	22.6
	.....do	8.24	69.5	30.5	13.59	.....	.910	.550	0.090	.....	4.18	.....	.36	4.54	− 1.30	− 1.76	30.0
884	Hicacos en almibar	.....	.....	.....	65.07	3.51	.142	.192	.058	.119	20.82	40.17	39.26	60.08	+33.50	−20.40	22.8
905	.....do	.....	.....	.....	66.25	2.07	.124	.156	.058	.244	12.17	50.91	50.47	62.64	+48.00	−18.26	23.0
	Marofion	70.0	85.9	14.1	12.84	.....	.360	.210	.310	.....	6.37	.....	.39	6.76	− 1.70	− 2.20	29.0
888	Marofiones (preserved)	.....	.....	.....	71.22	2.57	.135	.111	.078	.255	27.59	40.08	39.30	66.89	+31.65	−19.80	22.8
693	Caimito (purple)	.....	68.20	31.80	15.96	5.54	.442	.272	.120	.910	6.67	.26	.....	6.93	− 2.60	− 2.76	20.0
	.....do	208.0	41.80	58.20	14.23	.....	.350	.230	.050	.670	4.01	.....	3.90	7.91	+ 2.00	− 3.25	26.0
694	Caimito (white)	.....	67.20	32.80	17.19	5.42	.512	.321	.494	.710	8.27	1.05	1.28	9.55	− 1.60	− 3.30	20.0

HICACO.

(*Chrysobalanus icaco.*)

This is the fruit of a small shrub and is sometimes called the cocoa plum. It is small and round, varying from 1 to 3 inches in diameter, and averages about 8 grams (one-quarter ounce) in weight. The skin is thin and green in color, shading to red on one side. The surface is uneven, being covered with depressions which give it a shriveled appearance. The seed is large, weighing almost half as much as the fruit. The fruit is not eaten when fresh, and the two samples of preserves examined show the usual low acid content (Table IX) and no other features of interest. One sample was packed in glass and the other in tin.

CASHEW (MARAÑON.)

(*Anacardium occidentale.*)

The cashew is a small, oddly-shaped, yellow and red fruit, 2 or 3 inches long, and from 1½ to 2 inches across the bottom, decreasing gradually in diameter toward the top, where it is half an inch narrower.

The seed is small, grayish brown, and kidney-shaped, and is found on the outside of the fruit, at its lower extremity. This seed is poisonous until roasted, when it is eaten with great relish. The meat resembles that of roasted chestnuts, but contains more oil.

The pulp is of a dull yellow color, tough, and very juicy, with an acid astringent flavor and a marked, disagreeable odor. The fruit is not eaten raw, but is somewhat used for preserving. The sample of the preserves examined (Table IX) consists of the whole fruit put up in glass in a very heavy sugar sirup. The flavor is insipid, owing to the very low acid content. The fruit retails at from 10 to 30 cents a dozen.

STAR-APPLE (CAIMITO).

(*Chrysophyllum cainito.*)

The caimito, one of the less important fruits, is but little used, although some medicinal properties are attributed to it. Three different varieties are sold in the Havana market, one white and two purple kinds, one of which is round and the other oval. The white variety brings a slightly higher price and the sample of it examined appears to be somewhat superior, as is shown in Table IX.

The fruit attains the size of a small apple, averaging 200 grams (7 ounces) in weight. It contains two kinds of pulp, the inner one of which, a white gelatinous mass containing the small black seeds, is the edible portion, constituting only one-third of the fruit, the outer fibrous purple portion being useless. It has a sweet characteristic flavor and is eaten raw. No preserves were found on the market.

ANALYSES OF THE ASH.

The ash analyses[a] were made not to determine the fertilizing value, but rather to ascertain the presence or absence of any constituent which might be used in identifying the fruit. For this reason only the ash of the edible portion of the fruit itself was analyzed. The main difficulty presented by this part of the work was that only an extremely small sample was available for analysis, and, as it was impossible to allow separate portions of the sample for the chlorin and the carbon dioxid determinations, the latter was omitted. All determinations were made by the official methods of the Association of Official Agricultural Chemists.

TABLE X.—*Analyses of the ash of the edible portion of the several fruits.*

Description of sample.	Total ash.	Silica (SiO_2).	Potash (K_2O).	Lime (CaO).	Magnesia (MgO).	Ferric oxid (Fe_2O_3).	Phosphoric acid (P_2O_5).	Sulphuric acid (SO_3).	Chlorin (Cl).
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Orange (china)	0.52	1.01	40.66	10.26	5.27	1.09	8.56	2.84	2.44
Orange (rough skin)	.55	.....	49.15	2.62	1.41	4.51	7.42	3.42	1.50
Orange (sour)	.57	.....	45.09	7.95	2.17	2.40	8.70	2.72	.98
Grape fruit	.39	.....	44.19	7.34	3.92	1.28	11.09	3.39	1.38
Lime	.98	.....	43.01	7.84	2.36	.....	8.45	2.62	4.07
Sweet lemon	.98	.....	54.35	4.29	1.08	.....	9.83	4.09	1.32
Tamarind	1.56	[a]15.57	.....	.68	2.19	.....	4.99	1.40	.48
Guava	.84	1.13	55.00	2.48	1.64	.....	8.29	3.58	5.33
Banana (niño)	.70	.....	46.46	.95	.42	.....	10.36	2.36	6.59
Banana (oronoco)	1.08	.....	52.41	1.02	1.90	.....	5.16	3.32	8.48
Banana (colorado)	.83	.....	51.47	.37	.65	.....	3.25	2.77	7.63
Mango (French)	.53	.....	47.37	6.38	1.62	.....	6.49	3.67	3.88
Mango (Filipino)	.41	1.75	51.79	1.74	3.25	.....	9.04	4.88	1.56
Manga	.78	2.14	49.37	2.38	.....	.....	5.57	3.84	4.20
Guanabana	.86	1.48	48.93	.44	2.17	.....	9.15	4.54	5.40
Anon	.80	.63	47.27	.81	2.07	.....	13.63	3.19	3.51
Chirimoya	1.04	.....	49.73	2.21	.66	.....	6.57	4.49	7.40
Sapota	.50	.....	43.13	7.49	2.83	.....	2.74	4.55	17.41
Mamey (colorado)	.80	.....	50.57	1.38	1.36	.....	4.90	3.54	17.34
Do	.89	.....	48.20	1.73	3.35	.....	9.66	3.80	16.00
Hicaco	.91	.....	35.15	5.84	4.51	.....	3.09	4.77	18.62
Caimito	.35	.....	54.75	1.31	.....	.....	11.00	5.50	9.46
Pineapple	.....	.....	59.18	9.44	5.52	.....	6.51	3.04	3.22
Do	.....	.....	57.13	4.80	3.44	.....	4.29	3.65	4.08

[a] 2.88 per cent sand.

A study of Table X shows that the ashes of but few of the fruits are characteristic. The citrus fruits contain somewhat large amounts of lime and iron. Some analysts report as much as 25 per cent of lime, working undoubtedly on the whole fruit. The ash of the tamarind contains an extremely large amount of silica, of which not quite 3 per cent is sand. Banana ashes are low in lime and magnesia and high in

[a] The work on the ash was done entirely by E. M. Chace.

chlorin. Some published results on the composition of the ash of this fruit give as much as 27 per cent of chlorin. It is difficult to explain such results, inasmuch as the analyst worked upon the flesh alone and employed the usual methods of obtaining the ash. In order to ascertain the quantity of chlorin lost during the combustion of the pulp, two samples were ignited with sodium carbonate, the chlorin determined and calculated back to the ash. It was found that if all the chlorin occurring in the pulp could be obtained in the ash it would amount to only 16 per cent. Naturally a somewhat lower result was obtained by the writer using ordinary methods of combustion, but amounts of chlorin 10 per cent greater have been reported by another analyst.[a]

The ashes of the mangos and the anonæ show nothing characteristic; those of the mamey, sapota, and hicaco contain large amounts of chlorin, twice as much as any of the other samples, although the caimito also contains a large amount of this constituent. The pineapple ash shows no marked amount of any constituent by which it could be identified, though it contains more than the average amount of potash. In short, there is little about the ash of the fruits examined which would aid in identifying them.

[a] Report of the California Agr. Expt. Sta., 1892–1893, p. 277.

II.—THE COMPOSITION OF FRESH AND CANNED PINEAPPLES.[a]

The work undertaken in connection with the investigation of the composition of fresh and canned pineapples consists of the analysis of (1) fresh pineapples from various sources; (2) canned pineapples which were put up under supervision of the consuls-general of the United States at Singapore and Nassau, and (3) commercial samples of canned pineapples.

DESCRIPTION OF SAMPLES.

Of the 38 samples of fresh pineapples examined, 21 were from Florida, 10 from Cuba, 4 from Porto Rico, 2 from the Bahamas, and 1 from Jamaica. The Florida pineapples were largely obtained from representative growers; the Cuban pineapples were nearly all purchased on the market at Havana; the Porto Rican pineapples were obtained from F. D. Gardner, director of the Porto Rican Experiment Station; the Bahama samples were obtained on the market in New York; and the sample from Jamaica was obtained in the Washington market. So far as possible the samples obtained were the well-ripened fruit, but in some cases they were shipped so far that it was not practicable to use the thoroughly ripened fruit, but such as would stand shipment. Samples 804 to 808 and 818 were secured early in the season, and were very green. Their composition shows them to be of inferior quality, and therefore they have been excluded from the averages for total solids and for sugars. The first sample of fresh pineapples was received March 4, 1902, the last sample September 26, 1902, and samples were secured at varying intervals between these dates.

Sixteen samples of canned pineapples were obtained from the consul-general at Singapore. Of this number, 10 were put up in the normal pressed juice of the pineapple without addition of cane sugar and 6 were put up in the expressed juice to which cane sugar had been added. Two samples were obtained from the consul-general at Nassau, preserved without addition of cane sugar.

The 42 samples of commercial canned pineapples came from Singapore, the Straits Settlements, and the Bahamas.

METHODS OF ANALYSIS.

The methods of analysis employed in this work were essentially those given under "Fruits and Fruit Products, Provisional Methods for the Analysis of Foods," Bulletin 65, Bureau of Chemistry. The total solids were determined by drying in a water oven with asbestos for twenty hours. Solids in the sirup were calculated from the specific gravity, using the table of H. Ellion. Reducing sugars were

[a] This work was done by Mr. Munson and Mr. Tolman, and appeared in part in the Journal of the American Chemical Society in March, 1903.

determined by Meissl's method for invert sugar, and cane sugar was determined both by the increase in reduction after inversion with hydrochloric acid and by double polarization. The polarimetric method used was that of the German official chemists, and cane sugar was calculated by the Herzfeld formula:

$$S=\frac{100\,(A-B)}{141.89+0.05B-\frac{T}{2}}$$

Results by the two methods agreed very closely, especially where the amount of cane sugar was small. With samples of high content of cane sugar, the results by the reduction method were less reliable, owing to the influence of the cane sugar upon the reduction.

While the acids of pineapples are largely citric they are expressed in this paper as sulphuric acid for the purpose of comparison.

ANALYTICAL DATA.

Table XI contains the results of analysis of the fresh pineapples. As will be seen by reference to this table, there is no material difference in composition due to the source of the pineapples; neither does the variety seem to have any influence on the composition. Insoluble solids, ash, acids, and protein do not show a wide variation, while on the other hand the samples show a wide difference in the content of sugars. As is well known, the sugars develop very rapidly with the ripening of the fruit, but the other constituents appear to be present in equally large amounts in the green fruit. Of particular interest are the relative amounts of reducing and cane sugars in the fresh fruit. In nearly all cases the cane sugar is largely in excess of the reducing sugar. The average amount of reducing sugar in all the samples of fresh fruit is 3.91 per cent, while the average amount of cane sugar is 7.59 per cent, nearly double the amount of reducing sugar.

Table XII contains the results of analysis of the pineapples canned under direction of the consuls-general at Singapore and Nassau. The samples put up without addition of cane sugar were preserved in expressed pineapple juice, the amount of juice added being about 30 per cent of the entire contents of the can. As far as content of total sugars is concerned, therefore, the composition of these canned pineapples should not be materially different from the composition of the normal fresh fruit. Other constituents, especially insoluble solids, will be lowered by the addition of the juice, as comparison of Tables XI and XII shows. While the amount of total sugar is practically the same as in the fresh fruit, the relative proportions of reducing and cane sugars are entirely different, due to the inverting action of the organic acids during the processes of canning. In many cases the amount of the cane sugar remaining is quite small, the average for all the samples being 3.41 per cent of cane sugar and 7.99 per cent of reducing sugars—just the reverse of the condition in the fresh fruit. This condition also holds in the samples put up with addition of cane sugar and with the commercial samples.

TABLE XI.—*Composition of fresh pineapples.*

Laboratory No.	Variety.	Solids.		Ash.		Acids as sulphuric.	Protein (N×6.25).	Sugars.			Polarizations.		
		Total.	Insoluble.	Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose.	Total as invert.	Direct.	Invert.	Temperature.
	Florida:	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	°*V.*	°*V.*	°*C.*
571	Spanish red.	11.93	1.60	0.438	0.321	0.847	0.406	1.94	5.98	8.24	4.75	−3.08	22.0
807	Unknown ..	a8.06	1.55	.326	.390	.366	.494	a1.74	a2.96	a4.86	1.85	−2.20	23.4
808	Do.....	a10.19	1.59	.434	.497	.825	.419	a1.44	a5.37	a7.09	4.35	−2.30	28.4
1054	Spanish red.	16.53	1.48	.505	.377	.509	.418	5.89	8.71	15.06	6.70	−4.45	28.0
1055	Porto Rico..	12.27	1.48	.408	.345	.307	.262	4.06	6.49	10.89	5.00	−3.30	28.0
1056	Egyptian queen....	18.86	1.47	.548	.377	.483	.381	5.20	8.48	14.13	6.85	−4.01	28.0
1059	Sugar loaf ..	15.06	1.51	.356	.337	.....	.275	3.64	9.12	13.24	8.00	−3.85	30.0
1060	Spanish red.	13.30	1.55	.361	.243	.....	.474	4.40	6.48	11.22	5.00	−3.30	30.0
1061	Abakka.....	10.78	1.45	.385	.292	.....	.331	3.95	4.68	8.88	3.90	−2.20	30.0
1062	Blood.....	11.82	1.29	.446	.317	.....	.406	3.02	6.13	9.48	5.15	−2.75	30.0
1063	Spanish red.	17.52	1.68	.428	.374	.....	.418	4.54	10.20	15.28	8.55	−4.62	30.0
1064	Smooth cayenne ..	12.93	1.27	.378	.355	.444	.400	3.17	7.51	11.08	6.20	−3.30	27.8
1066	Do.....	14.85	1.03	.373	.322	.445	.393	9.75	2.98	12.89	0.20	−3.63	27.8
1067	Abakka.....	13.70	1.31	.349	.278	.465	.419	5.28	6.35	11.97	4.70	−3.52	27.8
1068	Porto Rico..	12.20	1.84	.526	.478	.545	.569	3.98	6.03	10.33	4.60	−3.08	27.8
1069	Abakka.....	12.73	1.27	.466	.418	.620	.306	4.38	6.22	10.93	4.80	−3.30	27.8
1070	Spanish red.	13.10	1.49	.464	.596	.300	.475	4.52	6.53	11.40	5.20	−3.19	27.8
1071	Pernambuco	15.60	1.68	.487	.403	.560	.406	4.33	8.27	13.03	6.50	−4.23	27.8
1092	Egyptian queen.....	13.62	.....	.479	.459	.565	.469	3.62	7.44	11.45	6.40	−3.08	30.0
1093	Abakka.....	11.02	1.02	.395	.276	.400	.338	4.08	4.91	9.45	3.40	−3.02	25.8
1125	Spanish red.	15.25	.....	.401	.316	.560	.494	4.53	8.22	13.19	6.70	−4.20	21.0
	Average ...	13.85	1.45	.421	.370	.515	.407	4.44	6.88	11.69	.....	.....	.....
	Cuban:												
572	Spanish red.	12.63	1.35	.272	.272	.561	.406	2.19	6.81	9.36	6.70	−2.36	21.0
646	Sugar loaf ..	11.45	1.70	.324	.355	.646	.206	1.76	6.12	8.20	4.80	−3.19	23.0
647	Spanish red.	14.12	1.64	.319	.328	.602	.381	3.00	8.76	12.23	7.10	−4.33	23.0
802	Do.....	13.45	1.63	.457	.461	.670	.475	2.31	8.23	10.97	7.20	−3.57	27.6
803	Sugar loaf..	12.67	1.80	.277	.223	.502	.513	2.76	6.77	9.89	5.90	−3.09	27.6
804	Unknown ..	a9.13	1.49	.313	.353	.673	.512	a1.34	a4.60	a6.18	3.50	−2.53	23.4
823	Spanish red.	17.53	1.54	.425	.401	.511	.387	3.76	10.48	14.79	9.20	−4.18	28.6
855	Sugar loaf..	16.53	1.33	.342	.360	.457	.363	4.55	9.43	14.48	8.10	−4.29	22.6
860	Spanish red.	15.38	1.81	.444	.476	.624	.375	2.84	9.65	12.00	8.35	−4.07	25.8
1053	Sugar loaf..	16.99	1.64	.296	.327	.359	.357	4.65	9.73	14.89	8.50	−3.90	26.0
	Average ..	14.52	1.59	.347	.356	.561	.397	3.09	8.44	11.87	.....	.....	.....
	Bahama:												
809	Unknown ..	14.97	1.52	.387	.410	.798	.500	2.56	9.18	12.23	8.10	−4.07	28.4
868	Spanish red.	14.65	1.59	.408	.409	.747	.462	2.75	8.98	12.21	7.85	−3.74	25.8
	Average ..	14.81	1.56	.398	.410	.772	.481	2.65	9.08	12.22	.....	.....	.....
	Porto Rican:												
805	Unknown ..	a8.69	1.64	.416	.399	.697	.431	a1.35	a3.67	a5.22	2.30	−2.36	23.4
818	Cabezona ...	a8.48	1.63	.332	.304	.807	.519	a2.74	a3.30	a6.22	2.30	−1.92	28.6
819	Pan de Azucar.....	14.14	1.69	.404	.437	.524	.444	2.97	8.22	11.62	7.15	−3.41	28.6
820	Caraquena..	17.69	1.83	.333	.370	.838	.531	4.59	9.97	15.09	8.20	−4.62	28.6
	Average ..	15.91	1.70	.371	.378	.716	.481	3.78	9.09	13.36	.....	.....	.....

a Not included in averages.

TABLE XI.—*Composiuion of fresh pineapples*—Continued.

Laboratory No.	Variety.	Solids.		Ash.		Acids as sulphuric.	Protein (N × 6.25).	Sugars.			Polarizations.		
		T. tal.	Insoluble.	Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose.	Total as invert.	Direct.	Invert.	Temperature.
	Jamaica:	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	°*V.*	°*V.*	°*C.*
806	Unknown..	[a]9.23	1.48	.410	.410	.646	.475	[a]1.28	[a]4.67	[a]6.19	3.55	−2.58	23.4
	Average of allsamples	14.17	1.52	.396	.370	.603	.420	3.91	7.59	11.90	.....	.....	.....
	Maximum..	18.86	1.83	.548	.596	.847	.569	9.75	10.48	15.28	.....	.....	.....
	Minimum ..	10.78	1.02	.272	.223	.300	.206	1.76	2.98	8.20	.....	.....	.....

TABLE XII.—*Composition of canned pineapples put up under direction of consuls-general at Singapore and Nassau.*

PRESERVED IN NATURAL JUICE WITHOUT ADDITION OF CANE SUGAR.

Source and laboratory No.	Solids.		Ash.		Acids as sulphuric.	Protein (N × 6.25).	Sugars.			Polarizations.		
	Total.	Insoluble.	Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose.	Total as invert.	Direct.	Invert.	Temperature.
Singapore:	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	°*V.*	°*V.*	°*C.*
1103	14.34	1.18	0.447	0.312	0.450	0.566	8.92	3.28	12.38	0.90	−3.30	23.0
1104	14.26	1.31	.357	.295	.466	.562	9.54	3.34	13.06	.90	−3.52	23.0
1105	14.41	1.20	.474	.338	.472	.438	10.96	1.85	12.91	−1.10	−3.52	23.0
1106	13.48	1.15	.476	.329	.490	.481	9.56	2.44	12.13	0.00	−3.20	23.0
1107	17.44	1.44	.434	.352	.436	.488	10.56	4.11	14.89	1.60	−3.80	24.4
1108	13.10	1.34	.309	.257	.450	.506	7.44	4.20	11.86	2.30	−3.20	24.4
1109	10.96	1.16	.242	.214	.250	.500	5.84	3.85	9.90	2.30	−2.65	24.4
1111	11.70	1.62	.333	.301	.333	.412	7.53	2.08	9.72	.30	−2.50	24.4
1112	11.28	.87	.330	.253	.294	.444	6.59	3.00	9.83	1.40	−2.60	24.4
1113	12.95	1.83	.391	.308	.299	.356	7.30	3.17	10.64	1.60	−2.70	24.4
Average	13.39	1.31	.379	.300	.389	.475	8.42	3.13	11.73	.....	.....	.....
Nassau:												
1013	10.00	1.07	.257	.300	.443	.250	5.44	2.96	8.55	1.65	−2.09	26.0
1014	16.35	2.18	.563	.663	.711	.456	6.20	6.61	13.16	4.65	−3.68	26.0
Average	13.18	1.63	.410	.482	.577	.403	5.82	4.79	10.86	.....	.....	.....

PRESERVED IN NATURAL JUICE WITH ADDITION OF CANE SUGAR.

Singapore:												
1114	18.07	1.02	0.370	0.286	0.378	0.412	11.93	4.63	16.70	1.50	−4.50	24.4
1115	18.48	1.38	.267	.164	.202	.350	12.68	4.88	17.82	1.55	−4.75	24.4
1116	18.15	1.60	.460	.329	.260	.400	7.51	8.82	16.80	7.00	−4.30	24.4
1117	18.61	2.06	.505	.336	.284	.456	9.02	7.83	17.26	6.50	−4.60	24.4
1118	19.11	1.25	.450	.328	.417	.450	15.39	2.41	17.93	1.65	−4.80	24.4
1119	16.61	1.33	.334	.234	.378	.375	13.28	2.28	17.93	.20	−4.25	24.4
Average	18.17	1.44	.398	.280	.320	.407	11.63	5.14	17.41	.....	.....	.....

[a] Not included in averages.

TABLE XIII.—*Canned pineapples from Singapore, Straits Settlements, and the Bahamas.*

SINGAPORE (TWENTY-ONE SAMPLES).

Laboratory No.	Specific gravity of sirup.	Solids in sirup.	Solids.		Ash.		Acids as sulphuric.	Protein. (N.×6.25)	Sugars.			Polarizations.		
			Total.	Insoluble.	Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose.	Total as invert.	Direct.	Invert.	Temperature.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	° *V.*	° *V.*	° *C.*
589	1.0844	19.57	20.38	1.22	0.294	0.208	0.291	0.431	9.25	7.63	17.28	4.60	−5.39	22.5
590	1.0927	21.35	22.36	1.67	.315	.235	.245	.444	8.57	9.69	18.77	7.30	−5.39	22.5
591	1.1112	25.30	26.84	1.03	.214	.193	.173	.456	7.75	16.48	25.10	15.00	−6.60	22.5
592	1.0824	19.13	19.40	1.23	.363	.282	.242	.469	11.66	4.34	16.23	.60	−5.06	22.5
593	1.0975	22.37	23.36	1.20	.309	.242	.433	.388	13.73	5.70	19.73	1.30	−6.16	22.5
594	1.0799	18.59	19.78	1.35	.319	.258	.392	.463	9.76	5.92	15.99	2.80	−4.95	22.5
597	1.0849	19.68	20.72	1.19	.287	.219	.316	.394	10.13	6.78	17.27	3.60	−5.28	22.0
599	1.0780	18.18	19.16	.99	.269	.214	.278	.444	11.87	4.62	16.73	.00	−4.62	22.5
601	1.0925	21.31	22.26	1.20	.303	.230	.245	.406	9.15	7.74	17.29	4.90	−5.17	24.0
602	1.0853	19.81	20.91	1.39	.296	.220	.230	.506	7.05	8.63	16.13	6.60	−4.62	24.0
603	1.0903	20.84	22.11	1.26	.345	.279	.274	.475	8.98	7.43	16.80	4.60	−5.06	24.0
604	1.0788	18.35	19.98	1.31	.279	.204	.259	.569	8.96	5.61	14.87	2.90	−4.40	24.0
606	1.0887	20.49	21.61	.98	.243	.206	.286	.438	9.55	6.97	16.89	4.00	−5.06	24.0
607	1.0881	20.37	21.55	.96	.251	.198	.156	.419	9.34	8.66	18.46	6.20	−5.06	24.0
609	1.0780	18.18	19.43	1.30	.288	.220	.254	.450	8.63	7.07	16.08	4.80	−4.40	24.0
612	1.0789	18.37	19.15	1.12	.318	.271	.249	.462	8.36	8.77	17.59	6.00	−5.50	22.0
615	1.0904	20.86	21.32	1.17	.265	.282	.294	.525	9.98	9.52	20.00	6.10	−6.38	22.0
617	.....	.....	18.45	1.06	307	.210	.294	.513	9.97	6.25	16.55	3.80	−4.40	22.0
619	1.0875	20.24	20.80	1.02	.208	.164	.203	.525	10.31	8.95	19.73	5.90	−5.83	22.0
621	1.0836	19.40	20.42	.92	.240	.175	.262	.481	9.01	9.19	18.69	7.10	−4.95	22.0
622	1.0896	20.67	21.76	1.02	.254	.225	.276	.419	9.82	9.53	19.85	7.10	−5.39	22.5
Average	1.0871	20.15	21.03	1.17	.284	.225	.269	.461	9.61	7.88	17.90	5.01	−5.22	.....
Maximum	1.1112	25.30	26.84	1.67	.363	.282	.433	.569	13.73	16.48	25.10	15.00	−6.60	.....
Minimum	1.0780	18.18	18.45	.92	.208	.164	.156	.388	7.05	4.34	14.87	.00	−4.40	.....

TABLE XIII.—*Canned pineapples from Singapore, Straits Settlements, and the Bahamas*—Continued.

STRAITS SETTLEMENTS (TEN SAMPLES).

Laboratory No.	Specific gravity of sirup.	Solids in sirup.	Solids.		Ash.		Acids as sulphuric.	Protein (N.×6.25)	Sugars.			Polarizations.		
			Total.	Insoluble.	Total.	Alkalinity as potassium carbonate.			Reducing.	Sucrose.	Total as invert.	Direct.	Invert.	Temperature.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	°*V.*	°*V.*	°*C.*
600	1.0795	18.50	19.12	1.22	0.322	0.239	0.259	0.394	9.45	4.84	14.54	2.00	−4.29	24.0
605	1.0811	18.85	20.43	1.24	.242	.194	.171	.531	8.53	6.78	15.67	4.20	−4.60	24.0
608	1.0828	19.22	20.68	1.27	.274	.250	.245	.394	7.70	7.55	15.65	5.20	−4.20	24.0
610	1.0842	19.52	19.91	1.13	.279	.235	.298	.488	11.96	6.29	18.58	2.70	−5.55	22.0
611	1.0717	16.79	17.32	1.06	.241	.204	.249	.488	7.77	8.04	16.23	5.70	−4.84	22.0
614	1.0898	20.73	21.56	.98	.242	.324	.298	.444	15.18	4.70	20.13	.00	−6.16	22.0
616	1.0850	19.70	20.10	1.04	.238	.167	.205	.569	10.99	7.35	18.73	4.35	−5.94	22.0
618	1.0998	22.86	24.28	.97	.224	.207	.296	.444	11.40	10.01	21.94	7.30	−6.05	22.0
620	1.0964	22.19	23.18	.91	.291	.294	.323	.475	11.53	9.18	21.19	6.20	−5.83	22.0
623	1.0980	22.47	23.81	.98	.237	.138	.245	.431	10.55	10.65	21.76	7.70	−6.27	22.0
Average	1.0868	20.08	21.04	1.08	.259	.225	.259	.466	10.51	7.54	18.45	4.53	−5.37	.....
Maximum	1.0998	22.86	24.28	1.27	.322	.324	.323	.569	15.18	10.65	21.94	7.70	−6.27	.....
Minimum	1.0717	16.79	17.32	.91	.224	.138	.171	.394	7.70	4.70	14.54	.00	−4.20	.....

BAHAMAS (TWELVE SAMPLES).

595			26.78	1.53	0.383	0.337	0.482	0.319	12.84	9.05	22.43	4.70	−7.15	22.5
596	1.0711	16.66	17.41	.88	.254	.199	.352	.213	8.64	6.54	15.54	4.50	−4.07	22.0
634	1.0640	15.08							9.65	3.23	13.07	1.00	−4.40	22.0
635			10.31	1.56	.477	.254	.678	.456	6.39	.53	6.95	−1.50	−2.35	22.0
636			14.30	1.30	.469	.340	.776	.406	7.25	.80	8.10	−2.40	−3.70	22.0
633	1.0509	12.13	12.99	1.18	.360	.325	.396	.356	6.46	4.00	10.70	1.60	−3.63	23.0
643	1.0524	12.47	12.80	1.22	.448	.343	.534	.400	8.05	1.90	10.06	− .70	−3.19	23.0
644	1.0345	8.33	8.54	1.01	.319	.275	.445	.350	5.55	.74	6.33	− .90	−1.87	23.0
645	1.0405	9.73	11.53	2.51	.222	.216	.220	.200	6.06	2.13	8.32	.80	−1.98	23.0
650	1.0440	10.54	10.92	1.09	.378	.358	.524	.288	7.45	1.03	8.54	−1.40	−2.75	23.0
637			15.72	1.62	.497	.388	1.176	.363	9.24	.62	9.90	− .50	−1.32	23.0
851[a]			10.33	1.51	.414	.421	.654	.363	7.99	.29	8.30	−2.00	−2.53	22.6
Average	1.0511	12.13	13.78	1.40	.384	.314	.567	.338	7.96	2.57	10.69	+ .27	−3.25	
Maximum	1.0711	16.66	26.78	2.51	.497	.421	1.176	.456	12.84	9.05	22.43	+4.70	−7.15	
Minimum	1.0345	8.33	8.54	.88	.222	.199	.220	.200	5.55	.29	6.33	−2.40	−1.32	

[a] Sample obtained from McCormick, Hubbs & Co., New York.

Table XIII contains the results of analysis of 43 samples of canned pineapples from Singapore, the Straits Settlements, and the Bahamas. It is apparent from the high content of sugars that practically all of the canned pineapples from Singapore and the Straits Settlements are preserved with addition of cane sugar. On the other hand, the analyses indicate that but few of the samples from the Bahamas have had any addition of cane sugar.

A study of the data contained in the foregoing tables fails to bear out the common supposition that the pineapples grown upon or near the equator contain more sugar than those grown at some distance farther north, and, in fact, the normal content of sugar in pineapples grown in Florida differs so little from that of pineapples grown at Singapore that the difference is practically negligible.

It may not be out of place to state at this point that these investigations were undertaken in the Bureau of Chemistry at the request of the Secretary of the Treasury for the purpose of establishing a basis of classification for imported pineapples for the guidance of the appraisers. Since the classification of these bodies for dutiable purposes depends upon the answer to the question of whether or not sugar has been added during the process of preserving, it was necessary first to establish the normal content of sugar in the pineapples. It is evident, from inspection of the analyses, that since the normal pineapples contain a large quantity of cane sugar, the mere presence of this substance would be no evidence whatever of its artificial addition. It is further evident that if a sirup containing practically the same quantity of sugar as the natural sirup of the pineapple were added it would be quite impossible, by a mere determination of the sugar present, to detect the addition. The only guide in this case would be to determine the relation of the sugar present to the total insoluble matters of the pineapple. If, on the other hand, a sirup rich in sugar were added in preserving, it would be easily detected by the increase in the percentage of sugar in the contents of the can.

In looking over the accessible literature relating to the analysis of pineapples, at the commencement of these investigations, it was surprising to find that no paper has been published on this subject except one by Buignet in "Les Sucres," published by Maquenne (Paris, 1900). The average content of sugar found by Buignet, viz, 13.9 per cent as invert sugar, is not materially different from the amount found in these investigations.

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